Use Class Re-Designation Procedures for Streams that have a Cold Water existing use

July 2012

Definitions

Designated Use – In this document, this term refers to the specific designated uses that may be grouped as part of a 'use class' as described in COMAR Section 26.08.02.02. Examples of designated uses are: water contact sports, fishing, the growth and propagation of fish (other than trout), other aquatic life and wildlife, agricultural water supply, and industrial water supply. Designated uses will always be referred to as 'designated uses' in this document.

Existing Uses – Definition taken from Code of Federal Regulations Title 40 § 131.3 – "Existing uses are those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards."

Stream – Used in this document to refer to flowing, non-tidal, linear water bodies of any stream order.

Use Class - This terminology refers to a class or grouping of specific designated uses that apply to a particular body of water. Examples of use classes provided in COMAR Section 26.08.02.02 include: I(-P), II(-P), III(-P), and IV(-P). This document occasionally refers to use classes simply as "uses". These terms can be considered synonymous and therefore, interchangeable.

I. Introduction

Maryland's Use Classes

Section 26.08.02.02 of the Code of Maryland Regulations (COMAR) identifies and defines the use classes for classifying Maryland State waters. There are four[1] main use classes or simply 'uses' described below:

- Use I: Water Contact Recreation, and Protection of Nontidal Warmwater Aquatic Life
- Use II: Support of Estuarine and Marine Aquatic Life and Shellfish Harvesting
- Use III: Nontidal Cold Water Aquatic Life
- Use IV: Recreational Trout Waters

Each use class includes a subset of specific designated uses that apply (e.g., fishing, water contact sports, warmwater aquatic life, etc). Non-tidal waters can be assigned a use of I(-P), III(-P), or IV(-P) based on the goal or existing use of a water body. COMAR section 26.08.02.08 specifies which use class is assigned to each river, estuarine segment, and impoundment. Many of these use class designations were made and promulgated in COMAR in the late 1970's and early 1980's. Since then, the state has increased the body of knowledge on aquatic species distributions, water quality, and habitat conditions. As a result, MDNR and MDE recommend that Section 26.08.02.08 be updated to reflect current information. Most often, a stream is not properly designated as having a use class of III(-P). In these cases the State has obtained data from a stream identified in COMAR 26.08.02.08 as Use I(-P) or IV(-P), but which demonstrates that the existing use of that stream is identical to a Use III(-P) water. In these cases, Maryland is obligated by both Federal and State water regulations to protect existing uses to the same extent

[1] In certain cases, each of these four use classes can have a "-P" suffix indicating that the public water supply designated use applies. However, not all waters are suitable as a public water supply and use of this suffix is limited.

it does designated uses. The following two paragraphs describe the regulations that address the protection of existing uses.

Federal Regulations Pertaining to the Protection of Existing Uses

Title 40 Chapter 1 Subchapter D of the Code of Federal Regulations establishes the basis for all federally mandated water protection programs. As such, Title 40 § 131.3 of the regulations specifically defines existing uses as "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." Federal regulations additionally discuss existing uses in 40 CFR § 131.12(a), part of the Code of Federal Regulations that establishes the basis for EPA and state Antidegradation Policy. Here the regulation asserts that "at a minimum…(1) Existing instream water uses and the level of water quality necessary to protect the existing uses shall be maintained and protected."

State Regulations Regarding the Protection of Existing Uses

COMAR Section 26.08.02.02 A. explicitly states that "(2) The actual uses of surface water are not limited to those designated in this chapter. Any reasonable and lawful use is permitted provided that the surface water quality is not adversely affected by the use." In addition, Maryland's Anti-degradation Policy (Section 26.08.02.04 A.) echoes the federal regulations by saying "Waters of this State shall be protected and maintained for existing uses and the basic uses of water contact recreation, fishing, protection of aquatic life and wildlife, and agricultural and industrial water supply as identified in Use I."

Incorporating Existing Uses into State Water Quality Standards

In light of these regulations and the data collected by State biologists, Maryland feels it necessary to modify state water quality standards section 26.08.02.08. To raise awareness and ensure adequate protection of these waters, Maryland will re-designate the use of those streams that demonstrate an existing use that is more protective than the currently assigned use in COMAR. For example, when a Use I (non-tidal warm water) stream demonstrates that the current existing use is that of a non-tidal coldwater stream (i.e., coldwater aquatic life is present), that stream will be re-designated in COMAR Section 26.08.02.08 as having a use class of III[2].

To address these kinds of scenarios, MDNR and MDE cooperatively developed this decision framework to document an objective and repeatable procedure for re-designating the use of a stream to Use III(-P). In creating this decision framework, Maryland borrowed and adapted many of the procedures used by other states including Pennsylvania, West Virginia, Idaho, New Jersey, and Virginia.

Specifically, it establishes procedures for determining the proper designated use of a stream under the following scenario:

- A Use I(-P), or IV(-P) water that could potentially be assigned a Use III(-P) designation

In all cases, if a water body is designated as Use III(-P) or satisfies the rules to be re-designated as Use III(-P), a Use III(-P) determination will always supersede a Use I(-P) or IV(-P) designation. In summary, the colder stream-type use classification will always override a

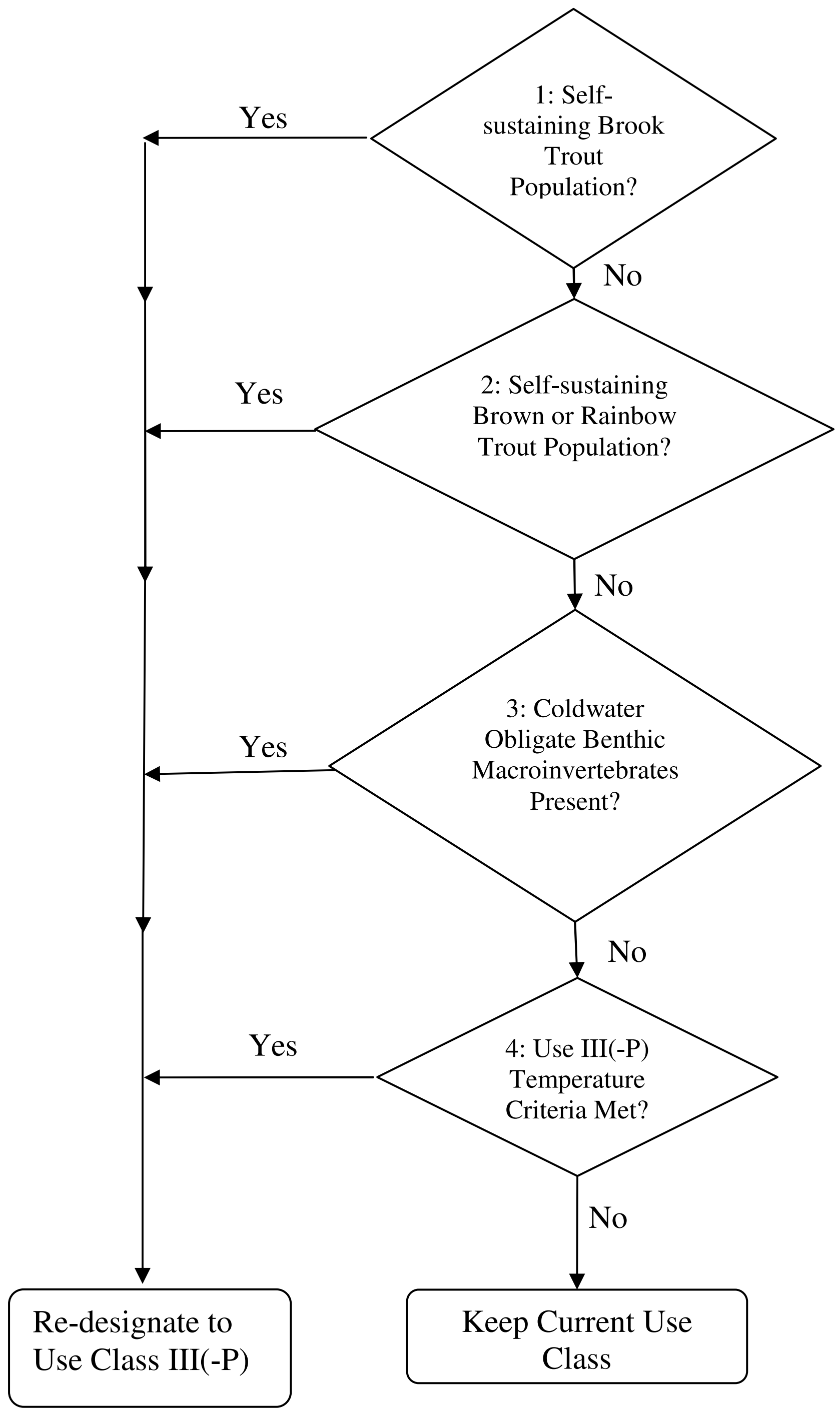
[2] Use class III streams have more stringent water quality criteria for temperature (≤ 20°C) and dissolved oxygen.(daily average ≥ 6mg/l).

warmer stream-type use classification. It will then be incumbent upon MDE to re-designate the use (based on the existing use of III) of such a stream in COMAR Section 26.08.02.08.

II. Decision Methodology for Re-Designating Water Uses

Decision Diagram for Re-designating a Stream to Use Class III(-P)

Note: only one of the four conditions outlined below is necessary for re-designation



Summary Information: Re-designating a Stream to Use Class III(-P)

(Numbers below correspond to decision diagram on page 5)

The rules, described below, provide information on how the state will determine the existing use of a water body. If a water body has been determined to exhibit the characteristics of use class III(-P) water, then the state will re-designate the use class of that water body to use III(-P) in COMAR Section 26.08.02.08. These procedures could be used to re-designate a water body from either use class I(-P) or IV(-P), to use class III(-P).

1. **Self-Sustaining Brook Trout Population**

   Rule: This rule is met if, during a single summer sampling event (summer: June - September), multiple age classes of adults (>1) are observed or young of year (YOY, age: 0+) brook trout are found.

   Justification: Brook trout (*Salvelinus fontinalis*) are Maryland's only native salmonid species and are typically found in the coldest headwater streams (first, second or third order). Summer stream temperature is the most important single factor influencing brook trout distribution and reproduction (Creaser 1930; MacCrimmon and Campbell 1969). Maryland DNR analyzed extensive water temperature and fish community data and determined that brook trout are the best fish species in Maryland to detect the presence of coldwater streams/rivers. A self-sustaining brook trout population can be identified and defined by multiple age classes of adults (minimum of 2) or simply by having YOY individuals. It is worth noting that, in time-series fish surveys, even self-sustaining brook trout populations can experience intermittent YOY production.

   Sampling Methods: It is necessary for all fish surveys to be conducted during the summer months of June, July, August or September since this is the period of time when thermal conditions for brook trout can be limiting. Young-of-year brook trout collected in these months are generally easiest to identify as 0+ age class based on their small size during this season. In all cases, resource biologists must review YOY data to confirm that suspected YOY are 0+ age class individuals and not undersized 1+ year old fish. Confirmation of a self-sustaining brook trout population by Maryland Department of Natural Resources biologists provides immediate justification for re-designating a stream to Use III(-P).

2. **Self-Sustaining Brown or Rainbow Trout Populations**

   Rule: This rule is only met if a summer fish survey finds multiple age classes of brown or rainbow trout adults (>1) and young of year (YOY, age: 0+) of that same species in a stream segment that has not been stocked within the last 5 years. A 'summer fish survey' is defined as one conducted on a date between June 1 and September 30.

   Justification: Brown (*Salmo trutta*) and rainbow trout (*Oncorhynchus mykiss*) are non-native fishes that have been introduced in Maryland to provide recreational fishing opportunities for anglers. Some of the introductions have resulted in naturalized populations where conditions are appropriate for their existence and reproduction. Since all of the trout species typically found in MD waters (brook, brown and rainbow trout) share very similar habitat and water temperature requirements, any waters inhabited by reproducing brown or rainbow trout shall be afforded the same use class protection as brook trout waters (i.e., Use III(-P)). A self-sustaining brown or rainbow trout population can be identified and defined by having multiple age classes of adults (minimum of 2) <u>and</u> age 0+ (young-of-year – YOY) individuals. Since stocked individuals are capable of traveling to and residing in unstocked areas, this rule requires the presence of YOY individuals to provide evidence of successful reproduction.

<u>Sampling Methods</u>: It is necessary for fish surveys to be conducted during the summer months of June, July, August and September since this is the period of time when thermal conditions for brown or rainbow trout can be limiting. Young-of-year brown and rainbow trout collected in the months of June, July, August or September are generally easiest to identify as 0+ age based on their small size during those months. In all cases, resource biologists must review YOY data to confirm that suspected YOY are 0+ age class individuals and not undersized 1+ year old fish.

3. **Presence of Obligate Coldwater Benthic Macroinvertebrates**

<u>Rule</u>: This rule is met if a single benthic macroinvertebrate sampling event reveals either *Sweltsa* or *Tallaperla* (stonefly) taxa in a stream.

<u>Justification</u>: Analysis of MBSS biological and temperature logger data has identified two benthic macroinvertebrate taxa, *Sweltsa* and *Tallaperla* (stoneflies), in stream reaches that have similar thermal regimes to brook trout streams (Appendix A, Graph 1). These obligate coldwater benthic taxa are found only in the coldest streams in Maryland. Life history information for both taxa indicates that they both have aquatic nymph stages of 18 months or more (Appendix A). The presence of either taxa in a single benthic sample identify a stream reach which has the necessary and sustained cold water temperatures required to support these taxa. As a result, the presence of either *Tallaperla* or *Sweltsa* warrants the re-designation of a stream to Use III(-P).

<u>Sampling Methods</u>: Sampling for benthic macroinvertebrates typically occurs during the months of March or April. This time period is selected to ensure that the aquatic nymph stage of the organisms can be collected at a size where they can be identified by benthic taxonomists.

4. **Use III(-P) Temperature Criteria**

<u>Rule</u>: This rule is met if all water temperature observations are below 20°C or 68°F. Water temperature readings must be recorded in 20 minute intervals or less, during a period from June 1 through August 31, during a single year, for a stream to be considered for Use III(-P) designation.

<u>Justification</u>: Since Code of Maryland Regulations (COMAR) define Use III(-P) in terms of a stream's capability to support coldwater obligate species, the requirements to re-designate a stream to Use III(-P) based on its temperature regime must be necessarily stringent. For that reason, in order to re-designate a stream as a Use III(-P) stream, all

temperature observations recorded between June 1 and August 31 must be less than 20°C.

Sampling Methods: Data from continuous temperature loggers are used to determine if the temperature criteria are met. Temperature loggers are deployed in streams/rivers from June 1 through August 31 to record water temperature typically at 20 minute intervals. When the temperature data is uploaded and analyzed, all data points are checked to ensure that loggers did not malfunction. For additional details on temperature monitoring and analysis, please see Maryland's Temperature Measurement Protocols for Wadeable Streams.

Use III(-P) - Geographic Scale of Use Reassignment

In most cases, when a use class evaluation results in a stream segment being redesignated to use class III(-P), the new use class III(-P) assignment will not only be applied to that particular stream segment but also upstream to include all tributaries to that stream segment. Likewise, this designation will be applied downstream from the sampled segment only to the next immediate confluence (as according to the 1:100,000 scale NHD). Applying the use class III(-P) re-designation in this manner thus protects a cold water stream from upstream sources of thermal pollution and is also consistent with how use classes are currently handled in COMAR Section 26.08.02.08. In addition, research by Maryland DNR and UMCES as part of the Eastern Brook Trout Venture has shown that maintaining suitable upstream habitat and temperatures is critical to supporting populations of brook trout, which often move upstream in the summer as water temperatures increase (Matthew Sell and Dr. Robert Hilderbrand, personal communication, June 6, 2012). The main exception to re-designating the entire upstream catchment as Use III(-P) will be when the Use III(-P) conditions (cold water below 20°C) are created by a bottom-release impoundment. In these cases, the Use III(-P) re-designation will continue upstream, only on the river mainstem, to the downstream end of the bottom-release dam. Since other unforeseen geographic scenarios may complicate this process, State biologists reserve the right to use best professional judgment when specifying the scale of a use class re-designation.

References

Idaho Department of Environmental Quality. Water Body Assessment Guidance. Second Edition – Final. January 2002.

New Jersey Division of Fish and Wildlife. Coldwater Fisheries Management Plan – Classification of NJ Trout Waters. Received from Debra Hammond on 10/19/2012.

New Jersey Division of Fish and Wildlife. 10/19/2012. Personal Communication with Debra Hammond, Bureau Chief, Water Standards and Assessment.

Pennsylvania Department of Environment Protection. 2/15/2012. Personal Communication with Tony Shaw, Chief of Monitoring Section, Division of Water Quality Standards.

Pennsylvania Department of Environment Protection Website. Accessed 2/15/2012. http://www.portal.state.pa.us/portal/server.pt/community/existing_use/10557.
Virginia Department of Environmental Quality. 2/15/2012. Personal Communication with Alex Barron, Water Quality Standards Program.

Maryland Department of Natural Resources and University of Maryland Center for Environmental Science. 6/6/2012. Personal Communication with Matthew Sell, DNR Brook Trout Fisheries Biologist and Robert Hilderbrand, Ph.D, University of Maryland Center for Environmental Science.

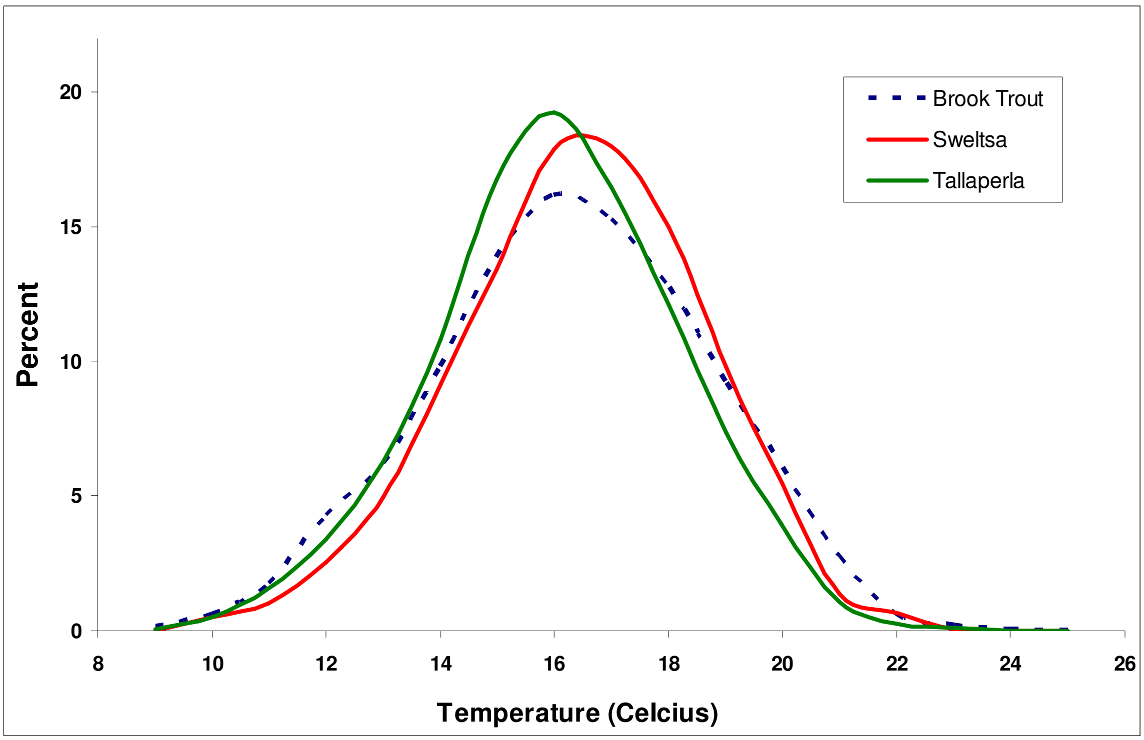
West Virginia Department of Environmental Protection Briefing Document. 2006. Rule Title: "Requirements Governing Water Quality Standards," 47CSR2. Rule adopted into W.Va. Code §22-11-4(a)(16); 22-11-7b. (obtained in personal communication with Michael Arcuri of WVDEP on 2/14/2012).

West Virginia Department of Environmental Protection. 2/14/2012. Personal Communication with Michael Arcuri, Environmental Resources Analyst, Water Quality Standards Program.

Appendix A: Obligate Coldwater Benthic Taxa

Table 1. List of obligate coldwater benthic taxa and temperature statistics

Genus	Order	Average Daily Mean Temperature (°C)	Daily mean temperature (°C) below which there is a 99 percent probability of taxa being observed
Tallaperla	Plecoptera	16.53	21.37
Sweltsa	Plecoptera	16.95	21.66
Brook Trout	Salmoniformes	16.78	22.12



Graph 1. Temperature distribution plot for *Sweltsa, Tallaperla* and reproducing brook trout.

Tallaperla (Plecoptera: Peltoperlidae)

Distribution and Conservation Status of *Tallaperla*

Seven species of *Tallaperla* occur in the United States and Canada. *Tallaperla* is an eastern North American species as it is not found west of the Mississippi River. All seven species in this genus occur in the southeast and/or northeast United States. One species has been reported from Maryland and three have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species are provided by InfoNatura (2007)]:

Maryland: *T. maria*-G5

Surrounding States: *T. anna*-G4 (VA), *T. cornelia*-G4 (VA), *T. lobata*-G2 (VA)

The Global conservation status ranks of species in *Tallaperla* are as follows: 1 G5, 2 G4, 2 G3, 1 G2, 1 G1G2.

Distribution of *Tallaperla* Species in Maryland

Tallaperla occurs in the eastern Piedmont and Highlands in northern Maryland. According to unpublished MBSS data, 74.4% of the sites at which *Tallaperla* have been collected occur in the Highlands and 25.6% occur in the eastern Piedmont. In eastern Maryland, the majority of *Tallaperla* records are from Harford County and Cecil County. The majority of western Maryland *Tallaperla* records are from Garrett County.

Life History and Ecology

Tallaperla nymphs are associated with leaf litter typically in riffle areas of erosional and depositional lotic systems. They are shredders-detritivores that primarily feed on leaf litter. The nymphs of *T. anna*, *T. cornelia*, and *T. lobata* are poorly known. As a defense mechanism, *Tallaperla* adults have been reported to autohemmorrage.

The life history and ecology of *T. maria* is well documented. Elwood and Cushman (1975) studied *T. maria* in a Tennessee stream. The eggs of these *T. maria* underwent a 7-8 month diapause. The nymphs were found in riffles among leaf packs and detritus. Detritus and diatoms were the primary contents found in the guts of the nymphs. Peak drift density primarily involved the younger cohort and occurred in March. In an Appalachian mountain spring population, Grubbs and Cummins (1996) found 1^{st}-year cohorts in mid-November. Their growth was slow during fall and winter and greatest growth occurred during spring and summer. In forested headwater streams in West Virginia, Yokum et al. (1995) report an 18 month nymph period with 14 instars and a 6 month egg diapause *T. maria* were restricted to sites with a baseflow alkalinity of >2mg L^{-1} $CaCO_3$ and were the dominant peltoperlid only at sites with an alkalinity of >15mg L^{-1}. Production of these nymphs (271 $mg \cdot m^{-2} \cdot y^{-1}$) was highest in the portion of the watershed underlain by limestone.

The majority of *T. maria* literature comes from the study of this species in Coweeta, North Carolina. Wallace et al. (1970) found that nymphs skeletonized leaves by feeding on the cuticle and mesophyll but not the vascular system of the leaves. This feeding increased the leaching of tannic acids from the leaves. The authors studied the feeding preferences of *T. maria* nymphs and found they preferred elm, sourwood, alder, and dogwood leaves while they least preferred rhododendron, white pine, white oak, and chestnut oak. Woodall and Wallace (1972) found that peaks in *T. maria* abundance were positively correlated with peaks in hardwood leaf detritus. In studying the drift behavior of *T. maria*, O'Hop and Wallace (1983) report that early instar nymphs are the dispersive stages of this species as a correlation between benthic density and number of early instar nymphs in drift samples was found. The authors also observed the nymphs drifting at night significantly more than during the day and the larger nymphs drifting more at night than during the day.

Voltinism

Semivoltine:

T. maria: PA (Grubbs and Cummins 1996); WV (Yokum et al. 1995); NC (O'Hop and Wallace 1983, O'Hop et al. 1984, Huryn and Wallace 1987); TN (Elwood and Cushman 1975); Quebec (Harper et al. 1991)

Emergence Pattern

T. cornelia: VA: mid May (Stark and Armitage 2000); NC: mid-May to mid-June (Stark and Armitage 2000)

T. maria: MD: mid-May to early July, 60 adults captured from Big Hunting Creek- reported as *T. elisa* (Duffield and Nelson 1990); WV: May-July (Yokum et al. 1995); NC: May (O'Hop et al. 1984)

Tolerance Values

Maryland 1.5, Pennsylvania 0, Southeast 1.4

Literature Cited

Duffield, R.M., and C.H. Nelson. 1990. Seasonal emergence patterns and diversity of Plecoptera on Big Hunting Creek, Maryland, with a checklist of the stoneflies of Maryland. Proceedings of the Entomological Society of Washington 92: 120-126.

Elwood, J.E., and R.M. Cushman. 1975. The life history and ecology of Peltoperla maria (Plecoptera: Peltoperlidae) in a small spring-fed stream. Proceedings-International Association of Theoretical and Applied Limnology 19: 3050-3056.

Grubbs, S.A., and K.W. Cummins. 1996. Linkages between riparian forest composition and shredder voltinism. Arhiv für Hydrobiologie 137: 39-58.

Harper, P.P. , M. Lauzon and F. Harper. 1991. Life cycles of sundry stoneflies (Plecoptera) from Quebec. Revue d'entomologie du Quebec 36:28-42.

Huryn, A.D., and J.B. Wallace. 1987. The exopterygote insect community of a mountain stream in North Carolina, USA: life histories, production, and functional structure. Aquatic Insects 9: 229-251.

InfoNatura: Animals and Ecosystems of Latin America [web application]. 2007. Version 5.0. Arlington, Virginia (USA): NatureServe. Available: http://www.natureserve.org/infonatura. (Accessed: March 5, 2010).

O'Hop, J.J., J.B. Wallace and J.D. Haefner. 1984. Production of a stream shredder, Peltoperla maria (Plecoptera: Peltoperlidae) in disturbed and undisturbed hardwood catchments. Freshwater Biology 14: 13-21.

Wallace, J.B., W.R. Woodall and F.F. Sherberger. 1970. Breakdown of leaves by feeding of Peltoperla maria nymphs (Plecoptera: Peltoperlidae). Annals of the Entomology Society of America. 63: 562-567.

Woodall, W.R., and J.B. Wallace. 1972. The benthic fauna in four small southern Appalachian streams. American Midland Naturalist 88: 393-407.

Yokum, K.A., T.R. Angradi and D.C. Tarter. 1995. Ecology of Peltoperla arcuata and Tallaperla maria (Plecoptera: Peltoperlidae) at the Fernow Experimental Forest, Tucker County, West Virginia. Psyche 102: 151-168.

Sweltsa (Plecoptera: Chloroperlidae)

Distribution and Conservation Status of *Sweltsa*

Thirty-two species of *Sweltsa* occur in the United States and Canada. Twenty-three species are exclusively western (west of the Mississippi River) and nine are exclusively eastern. Four species have been reported from Maryland and five species have been reported from States surrounding Maryland [Natureserve Global conservation status ranks for these species is provided by InfoNatura (2007)]:

Maryland: *S. lateralis*-G5, *S. onkos*-G5, *S. palearata*-G2G3, *S. pocahontas*-G2

Surrounding States: *S. holstonensis*-G1 (VA), *S. mediana*-G5 (VA), *S. naica*-G5 (PA, VA, WV), *S. urticae*-G4 (VA), *S. voshelli*-G3 (VA)

The Global conservation status ranks of species in *Swelsta* are as follows: 12 G5, 5 G4, 7 G3, 1 G2G3, 4 G2, 1 G1G2, 2 G1.

Distribution of *Sweltsa* Species in Maryland

In Maryland, *Sweltsa* has a scattered distribution in the Western Shore of the Coastal Plain and Piedmont with two areas of concentration: one in the Upper Monocacy watershed around Catoctin and the other in the Licking Creek watershed. The largest concentration of sites at which *Sweltsa* has been collected is in the counties of Allegany and Garrett in the Highlands province. 85.6% of the sites at which *Sweltsa* have been collected are in the Highlands, 9.6% are in the Eastern Piedmont, and 4.8% are in the Coastal Plain (MBSS, unpublished data). There is one record of *Sweltsa* from the Eastern Shore where it was collected from Marshyhope Creek.

The following is distribution information on *Sweltsa* species reported from Maryland (MD), including their North American (NA) range. The MD distribution information comes from Grubbs (1997) and the NA information from Surdick (2004) unless otherwise noted.

- *S. lateralis*: MD- streams and springs in Garrett County; NA- distributed throughout Appalachian mountains from GA and TN north to Quebec and New Brunswick
- *S. onkos*: MD- streams of varying sizes in Garrett, Allegany, and Washington counties, and Big Hunting Creek in Frederick County (Duffield and Nelson 1990); NA- throughout NE US from southern VA north to Ontario and Newfoundland
- *S. pocahontas*: MD- a rare Appalachian species collected from small springs in the Savage river drainage; NA- Ridge and Valley and Allegheny Plateau of WV and MD in upper drainage areas of the Greenbrier, Elk, and Little Kanawha Rivers and the North Branch of the Potomac River
- *S. palearata*: MD- a spring feeding Fifteen Mile Creek in Green Ridge State Forest, Allegany County; NA- Ridge and Valley Province of MD, WV, and northern VA in drainage areas of the upper Potomac River and the North and South Forks of the Shenandoah River

Distribution of non-Maryland *Sweltsa* Species in Surrounding States

Of the five *Sweltsa* species that have been reported from States surrounding Maryland, only one species, *S. naica*, is believed to occur in Maryland (Grubbs 1997). The reported range of *S. naica* is West Virginia and Virginia north to Labrador and Newfoundland. In Virginia, the other species (*S. holstonensis*, *S. mediana*, *S. urticae*, and *S. voshelli*) are primarily found in the southern Appalachians and are unlikely to occur in Maryland.

Life History and Ecology

Sweltsa individuals are typically found in cool fast-flowing temporary streams of mountainous areas (Stewart and Stark 2008, Surdick 2004). They are predators (engulfers) whose main prey items are chironomids and simuliids. At times, they are facultative collectors-gatherers.

The nymphs of chloroperlids are typically found among gravel and debris in riffle areas. According to Surdick (2004), the young instars of some chloroperlid species are found in surface gravel or in gravel substrate deep below the surface in the hyporheic zone while the older instars are found in riffles among rocks, debris, gravel, and submerged moss. In a southern Ontario stream, Mackay (1969) found *S. onkos* to be common in detritus, gravel, stones, leaves but not sand.

Various aspects of the life history and ecology of four *Sweltsa* species have been reported. In a cold springbrook (mean water temperature of 10.2°C in 1997 and 9.9°C in 1998) on Prince Edward Island, total production (P) of *S. naica* was 0.015 $g \cdot m^{-2} \cdot year^{-1}$ and annual Production/Biomass (P/B) was 3.7 (Dobrin and Giberson 2003). The authors reported the presence of two cohorts in samples which suggests a semivoltine 2-year cycle for *S. naica*.

Harper (1973) collected *S. onkos* from a southern Ontario stream and, in a lab, reared eggs and nymphs hatching from these eggs. The eggs developed slowly and took 113-173 days to hatch. The nymphs had a slow but continuous growth through the first winter and developed fast during the second summer. The final instar of these nymphs was present in February and March.

Cushman et al. (1977) studied *S. mediana* in an Appalachian Highland 1st-order stream in Tennessee. The authors suggest eggs of *S. mediana* undergo a seven month diapause due to early instar nymphs not appearing until December. Two cohorts were found December through May suggesting a semivoltine 2-year cycle. Maximum monthly density of *S. mediana* nymphs in July was 83+/-21 individuals/m^2. Biomass was reported as 61 mg/m^2 in April.

S. lateralis early instar nymphs were observed in August and September and the two cohorts grew slowly throughout the year in 1st- and 2nd- order streams in Coweeta, North Carolina (Huryn and Wallace 1987). The presence of two cohorts suggest a semivoltine 2-year synchronous cycle for *S. lateralis*. The cohort production interval (CPI) for *S. lateralis* was 630 days. (CPI refers to the interval in days from peak occurrence of the smallest size larval class until the onset of emergence)

The Ohio EPA and Idaho Department of Environmental Quality (ID DEQ) consider *Sweltsa* a cool water taxon (OHEPA 2009, Grafe et al. 2002, Stagliano et al. 2007). The ID DEQ determined the temperature preference of the genus to be 11.45°C (Grafe et al. 2002).

Voltinism

Semivoltine life cycle (2 years) is typical of *Sweltsa*.

Published reports of 2-year semivoltine life cycles among *Sweltsa* species:

S. onkos: southern Ontario (Harper 1973, Mackay 1969)

S. mediana: TN: Appalachian Highland 1st-order stream (Cushman et al. 1977)

S. lateralis: NC: 1st- and 2nd-order streams in Coweeta (Huryn and Wallace 1987)

S. naica: Prince Edward Island: from a cold springbrook (Dobrin and Giberson 2003)

Emergence Pattern

The emergence periods for each *Sweltsa* species will be presented separately below and are from Surdick (2004) unless otherwise noted.

S. holstonensis: mid-May

S. lateralis: NC: late April to late July; synchronous emergences in April-July in Coweeta

(Huryn and Wallace 1987)

S. mediana: TN: late April to early July; April-May in Appalachian Highland 1st-order stream (Cushman et al. 1977)

S. naica: New Brunswick, Canada: mid-May to late July; June-July (Giberson and Garnett 1996)

S. onkos: southern Ontario and Quebec, Canada: early April to early August; short, synchronous emergence in May (Harper 1973, Harper et al. 1991)

S. palearata: late May to late June

S. pocahontas: mid May to mid June

S. voshelli: late April to mid-June

Tolerance Values

Maryland 1.9, Pennsylvania 0, Southeast 0, Northwest 1

Literature Cited

Cushman, R.M., J.W. Elwood and S.G. Hildebrand. 1977. Life history and production dynamics of Alloperla mediana and Diplectrona modesta in Walker Branch, Tennessee. American Midland Naturalist 98: 354-364.

Dobrin, M., and D.J. Giberson. 2003. Life history and production of mayflies, stoneflies and caddisflies (Ephemeroptera, Plecoptera, and Trichoptera) in a spring-fed stream in Prince Edward Island, Canada: evidence for population asynchrony in spring habitats? Canadian Journal of Zoology 81:1083-1095.

Duffield, R.M., and C.H. Nelson. 1990. Seasonal emergence patterns and diversity of Plecoptera on Big Hunting Creek, Maryland, with a checklist of the stoneflies of Maryland. Proceedings of the Entomological Society of Washington 92: 120-126.

Giberson, D.J., and H.L. Garnett. 1996. Species composition, distribution, and summer emergence phenology of stoneflies (Insecta: Plecoptera) from Catamaran Brook, New Brunswick. Canadian Journal of Zoology 74: 1260-1267.

Grafe, C.S., Mebrane, C.A., McIntyre, M.J., Essig, D.A., D.H. Brandt and D.T. Mosier. 2002. The Idaho department of Environmental Quality Water Body Assessment Guidance, Second Edition-Final. Idaho Department of Environmental Quality, Boise, Idaho.

Grubbs, S.A. 1997. New records, zoogeographic notes, and a revised checklist of stoneflies (Plecoptera) from Maryland. Transactions of the American Entomological Society 123: 71-84.

Harper, P.P. 1973. Life histories of Nemouridae and Leuctridae in southern Ontario (Plecoptera). Hydrobiologia 41: 309-356.

Harper, P.P., M. Lauzon and F. Harper. 1991. Life cycles of sundry stoneflies (Plecoptera) from Quebec. Review of Entomology, Quebec 36: 28–42.

Huryn, A.D., and J.B. Wallace. 1987. The exopterygote insect community of a mountain stream in North Carolina, USA: Life histories, production, and functional structure. Aquatic Insects 9: 229-251.

InfoNatura: Animals and Ecosystems of Latin America [web application]. 2007. Version 5.0. Arlington, Virginia (USA): Natureserve. Available: http://www.natureserve.org/infonatura. (Accessed: March 5, 2010).

Mackay, R.J. 1969. Aquatic insect communities of a small stream on Mont St. Hilaire, Quebec. Journal of the Fisheries Research Board of Canada 26: 1157-1183.

OHEPA (Ohio Environmental Protection Agency). 2009. Field evaluation manual for

Ohio's primary headwater habitat streams. Final version 2.3. Division of Surface Water, Ohio Environmental Protection Agency, Columbus, Ohio. (Available from: http://www.epa.state.oh.us/portals/35/wqs/headwaters/PHWHManual_2009.pdf)

Stagliano, D. M., G. M. Stephens, and W. R. Bosworth. 2007. Aquatic invertebrate species of concern on USFS northern region lands. Report to USDA Forest Service, Northern Region. Montana Natural Heritage Program, Helena, Montana and Idaho Conservation Data Center, Boise, Idaho. 95 pp.

Stewart, K.W., and B.P. Stark. 2002. Nymphs of North American Stonefly Genera (Plecoptera) 2nd edition. The Caddis Press. Columbus, Ohio, U.S.A. 510 pp.

Surdick, R.F. 2004. Chloroperlidae (The Sallflies). *In* B.P. Stark and B.J. Armitage (editors). The stoneflies (Plecoptera) of eastern North America. Volume II, Chloroperlidae, Perlidae, and Perlodidae (Perlodinae). Bulletin of the Ohio Biological Survey, New Series 14 4:1-60.

Appendix B: Coldwater Benthic Taxa

Table 1. List of coolwater benthic taxa and temperature statistics

Genus	**Order**	**Average Daily Mean Temperature (°C)**	**Daily mean temperature (°C) below which there is a 99 percent probability of taxa being observed**
Cinygmula	Ephemeroptera	16.79	22.57
Wormaldia	Trichoptera	17.25	22.75
Diphetor	Ephemeroptera	17.52	23.08
Bittacomorpha	Diptera	19.11	23.18
Prodiamesa	Diptera	17.91	23.41
Paraleptophlebia	Ephemeroptera	17.58	23.42
Dixa	Diptera	18.38	23.43
Habrophlebia	Ephemeroptera	19.31	23.53
Alloperla	Plecoptera	17.72	23.55
Diplectrona	Trichoptera	18.38	23.58
Epeorus	Ephemeroptera	17.59	23.8
Ephemera	Ephemeroptera	18.14	23.8
Leuctra	Plecoptera	18.20	23.88
Heleniella	Diptera	18.21	23.88